COMMUTATIVITY OF ADDITION

SECTION 2

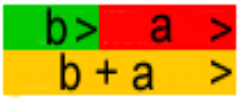
Were you able to verify that $a + b = b + a$ in each of the four cases?

YES {Go to VI below} NO {Go to I below}

I With which of the cases would you like help?

a and *b* both positive {Go to II below}
a and *b* both negative {Go to III below}
a positive and *b* negative {Go to IV below}
a negative and *b* positive {Go to V below}

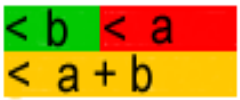
II Reconstruct the two figures below with the construction paper then check that $a + b = b + a$.



Now, have you been able to verify that $a + b = b + a$ in each of the four cases?

YES {Go to VI below} NO {Go to I above}

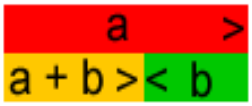
III Reconstruct the two figures below with the construction paper then check that $a + b = b + a$.



Now, have you been able to verify that $a + b = b + a$ in each of the four cases?

YES {Go to VI below} NO {Go to I above}

IV Reconstruct the two figures below with the construction paper then check that $a + b = b + a$.



Now, have you been able to verify that $a + b = b + a$ in each of the four cases?

YES {Go to VI below} NO {Go to I above}

V Reconstruct the two figures below with the construction paper then check that $a + b = b + a$.

Now, have you been able to verify that $a + b = b + a$ in each of the four cases?

YES {Go to VI below} NO {Go to I above}

VI GOOD JOB! Now here's another question. Of the three other basic arithmetic operations, subtraction, multiplication, and division, which are commutative?

None {Go to VII below}
Only Subtraction {Go to VIII below}
Only Multiplication (Go to XIV below}
Only Division {Go to IX below}
Subtraction and Multiplication {Go to X below}
Subtraction and Division {Go to XI below}
Multiplication and Division {Go to XII below}
All three {Go to XIII below}

VII: You are right about subtraction and division. Looking at 7 - 5 and 5 - 7 easily shows that subtraction is not commutative. Make up a similar example to show that division is not commutative. The commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

VIII: You are right that division is not commutative, but consider 7 - 5 and 5 - 7. Since these are not equal, subtraction is not commutative. The commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

IX You are right that subtraction is not commutative, which can be seen by looking at 7 - 5 and 5 - 7. Construct a similar example to show that division is not commutative. The commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

X You are right that multiplication is commutative, but consider 7 - 5 and 5 - 7. Since these are not equal, subtraction is not commutative. You are also right that division is not commutative. Can you show this by constructing an example similar to the one above for subtraction? The

commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

XI Well, let's think about this a little bit more. Suppose we look at 7 - 5 and 5 - 7. Since these are not equal, subtraction is not commutative. Construct a similar example to show that division is not commutative. The commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

XII You are right that multiplication is commutative as you will see in a future tutorial. You are also right that subtraction is not commutative, which can be seen by looking at 7 - 5 and 5 - 7. Construct a similar example to show that division is not commutative. Now go to Closing Remarks.

XIII You are right that multiplication is commutative, but consider 7 - 5 and 5 - 7. Since these are not equal, subtraction is not commutative. Construct a similar example to show that division is not commutative. The commutativity of multiplication is covered in a different tutorial. Now go to Closing Remarks.

XIV: You are exactly right. Looking at 7 -5 and 5 - 7 easily shows that subtraction is not commutative. Make up a similar example to show that division is not commutative. The commutativity of multiplication is covered in a different tutorial.

CLOSING REMARKS

As you go deeper into the subject of mathematics you will find that there are many other operations besides the basics of addition, subtraction, multiplication, and division. Every time you encounter a new operation you must ask yourself a key question: "Is this operation commutative?"

The next tutorial in this sequence is Commutativity of Multiplication. {Link to next tutorial.}

CHALLENGE EXERCISE

A square array of numbers such as $\begin{bmatrix} 3 & -5 \\ 6 & 12 \end{bmatrix}$ is called a matrix. We will define an operation, $\oplus$, on matrices by $\begin{bmatrix} a & b \\ c & d \end{bmatrix} \oplus \begin{bmatrix} e & f \\ g & h \end{bmatrix} = \begin{bmatrix} a+e & b+f \\ c+g & d+h \end{bmatrix}$. For example:

$$\begin{bmatrix} 3 & -5 \\ 6 & 12 \end{bmatrix} \oplus \begin{bmatrix} 2 & 7 \\ -8 & 4 \end{bmatrix} = \begin{bmatrix} 3+2 & -5+7 \\ 6+(-8) & 12+4 \end{bmatrix} = \begin{bmatrix} 5 & 2 \\ -2 & 16 \end{bmatrix}.$$

Can you verify that $\oplus$ is commutative? How would you do it?